Server Consolidation Study Executive Summary

Prepared for:

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and

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Executive Summary

State computer systems and the potential for their consolidation have often been a question and consideration for many within the State, including the State Chief Information Officer (CIO), the California Legislature, State agencies, and State departments. Advanced information processing within government is a necessity but has also been a growing cost.

In the Information Technology (IT) industry, discussions about server consolidation and virtualization[1] are common topics with many private sector companies engaging in projects to reduce the number of computers they use. Continuous advances in computer performance have created the opportunity for this type of consolidation and resulted in the average low utilization of many computer systems already deployed.

Server consolidation is primarily motivated by a desire for cost reduction. However, server consolidation directly reduces energy usage. This supports the State's power conservation initiatives and the Governor's Green Building Executive Order S-20-04.

Other strategic advantages that server consolidation can provide for the State include:
- Better security
- Support for Continuity of Government
- Enhancements for the California Public Records Act and e-discovery
- Improved use of facilities and resources
- Common services between departments

This study was commissioned to investigate server consolidation for the Executive Branch of California State Government. State agencies and departments outside the Executive Branch were invited to participate by the State CIO, in order to identify as many opportunities for efficiencies as possible. This study was led by IT professionals from Intel Corporation who have a wide range of experience in data center architectures and their computer systems.

Approach

The methodology used was to collect data, analyze it, and form recommendations. Data collection included gathering an inventory of computer servers within departments, conducting a web-based department survey of CIOs, doing background research, and conducting selected topical discussions and interviews.

After completing the data collection, the team performed an analysis of the data based on best practices for server consolidation and the team's expertise. The analysis led to five key recommendations covered in Chapter 8 – Key Recommendations. The team

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[1] **Virtualization -** a representation of a real machine using software that provides an operating environment that can run or host a guest operating system. Multiple virtual machines, i.e. servers, can be run in software on one physical machine.

also found additional opportunities for consolidation for departments to consider that are presented and discussed in Chapter 9 – Additional Opportunities.

To support the key recommendations, the team developed a Total Cost of Ownership (TCO) model based on data collected from the State and supplemented with industry data where State data was not readily available. This TCO model was then used for a cost and value analysis for four (4) of the key recommendations.

Growth Rates

Historic growth rates for installed servers within the State government are not known. In addition, the State does not have a projection for future growth rates. The industry average growth rate for the installed base of U.S. volume servers[2] over the past five years has averaged 12.4% annually. The estimated growth rate for the installed base of U.S. volume servers for the next four years is 9.9%[3]

We assume that tight IT budgets will limit the addition of new servers at the State. However, IT budgets will have funds to provide for server refresh. It is our estimation that without a special effort at reduction or consolidation; over the next five years the State will have:

- 5% annual growth rate of installed servers. This is 50% of the estimated 9.9% growth rate of U.S. volume servers and is based on assuming tighter budgets in California Government.
- 15% annual growth rate of online storage.

With current efforts by departments and a statewide focus on server consolidation, the installed base of servers could be reduced. A manageable three-year goal would be:

- 15% reduction of existing servers.
- 20% conversion of physical servers to virtual servers.

Summary of Data – Current Environment

Data Center Facilities

The team performed an on-site walkthrough review of the State's Gold Camp data center and held discussions concerning other facilities and plans to determine capability and capacity for hosting additional State computer systems if needed.

The team believes that with minor rearrangements and small modifications, the Gold Camp data center can play a significant long-term role in the State's server consolidation strategy. Gold Camp is a relatively new state-of-the-art facility with effective raised floor

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[2] IDC - Volume server market (consisting of all systems with an average sales value [ASV] below $25,000)
[3] Calculated from IDC data; see Growth Rate chapter in body of report for more information.

utilization below 50%, and power and cooling utilization as low as 26%. This leaves many opportunities to leverage the existing capabilities of this facility. For longer term planning, this facility can be expanded by build-out of another 20,000 ft^2 of raised floor space.

We intended to use survey and inventory data to assess other departmental computer room facilities. The data collected for this purpose was insufficient for this type of analysis. From interviews and conversations, we understand that there is a variety of computer rooms ranging from large data centers to server closets in office buildings.

Summary of Server Inventory

The server inventory collected information for a total of 6,082 servers. This is a large sample and we speculatively estimate that this number represents between 50% and 60% of the total servers.

A few key points from the analysis of the inventory are:

- Of the 6,082 servers, 5,753 were physical servers and 329 were virtual machines. This shows consolidation activity by some departments and that the adoption of server virtualization is already in progress. However, this is a low number of virtual machines and there is significant opportunity here.
- We attempted to categorize servers by a primary function. Of the 6,082 servers, 1,568 were application servers, 910 were File/Print, 653 were database, 430 were directory, 376 were e-mail, 362 were web, 975 were not classified, and the remainder is in other classifications.
- There were 910 file/print servers. This is a large number for this sample and provides a good opportunity for consolidation.
- There were 376 e-mail servers. This is excessive and is considered for consolidation.

Key Recommendations

The team presents five key recommendations titled:
- Data Centers
- In-Department Consolidation
- File Sharing and Document Management
- E-mail
- Virtualization

For each of these recommendations, we discuss details about our findings, the cost and value of the recommendation, and risks associated with adopting the recommendation.

With the exception of Data Centers, we develop scenarios that illustrate potential costs and savings. These are illustrative only but do represent realistic potential. We have remained conservative in our assumptions. However, actual cost and savings are dependent on a number of design considerations and implementation details.

There is overlap between those servers that would be eliminated in the In-Department Consolidation scenario and the File Sharing and E-mail scenarios. For this reason, it cannot be assumed that the cost and savings are additive across all of the key recommendations.

Data Centers

> **Recommendation:**
>
> The Gold Camp data center is significantly underutilized. A second facility is planned for co-processing, business continuity, and to replace the Cannery data center. No significant addition or expansion should be made to existing departmental computer room facilities. Rather, the Gold Camp and Cannery successor data center facilities should be utilized. Based on State-developed minimum requirements, current computer room facilities should be evaluated to determine if they meet the minimum requirements for security and continuity of operations commensurate with the applications and server functions they support. If not, the processing should be moved to the DTS data centers.

The question of data center consolidation and centralization came up frequently and is a controversial subject for some departments. Full discussion of this subject extends beyond this study and the implications of consolidation. There are organizational roles and responsibilities issues that need to be considered and addressed as part of the broader subject.

For this study, we considered the importance of data center utilization in the efficient use of resources. There are a number of computer room facilities within the State departments. These range from very small server room closets that host just a few servers to large, fully equipped data centers.

The cost savings / avoidance to the State are unknown but presumed to be substantial over time. The potential areas for cost savings / avoidance are:

- Using the existing DTS Gold Camp data center facility can improve utilization and efficiency.
  - Increasing utilization at the data center can be done with minimal additional facilities costs.
  - The underutilization at the data center causes the allocation of the facilities, resources, and staff to be spread over a reduced base of servers. If data center utilization was increased, the per server cost for facilities and services would be reduced substantially.
- Consolidating hardware support personnel builds better expertise across a reduced staff.
- Retrofitting existing departmental computer rooms to meet minimum standards would be costly.
- Building new facilities at one or more departments would be costly.

Key risks with centralizing servers include:

- The cost of implementation

- Increased WAN network requirements—relocating servers to a remote location from the users can increase WAN network requirements.
- Application downtime due to relocation
- DTS Rates—rates need to be comparable and reasonable to customers
- Incorrect determination of data center capacity

In-Department Consolidation

> **Recommendation:**
>
> The State CIO should set a goal to eliminate 15% of existing servers through combining workloads and services over the next three years. In addition, a plan should be developed with the cooperation of the departments to meet this goal. A *simple* quarterly tracking spreadsheet/system should be set up to record information by department. The system could track the total number of servers, the number of physical servers, the number of virtual servers, the number consolidated during the quarter, and the number virtualized during the quarter. The spreadsheet and progress should be reported quarterly to the State CIO.

While data center consolidation provides the largest cost avoidance and savings, it does not reduce the number of physical servers. The best opportunity for server consolidation remains with the departments. Server consolidation has been an industry initiative and best practice for several years and several State departments have completed some server consolidation or are consolidating servers now.

A cost and value scenario was developed to consider what the five year impact could be if 15% of servers were eliminated. For this "what-if?" scenario, it was assumed there are 9,000 servers and 1,350 were eliminated at the beginning of the first year. For this scenario, the savings would be $54M over five years. More details are covered in Overview of Cost and Value Analysis below.

Other benefits include:
- Reduction of IT staff workload
- Reduction of facilities requirements—this may extend the use of current facilities
- Consolidation savings can be applied to other projects

There are fewer risks with in-department consolidation but they include:
- Difficulty in combining applications or workloads
- Could create a more complex environment
- Applications on the same system image could interfere with each other and cause outages
- Cost of implementation

File Sharing and Document Management

> **Recommendation:**
>
> **Near-Term:** Where practical, sites with more than two co-located file servers should review utilization and consolidate these servers to two clustered file servers.
>
> **Strategic:** Evaluate the potential for applying Wide-Area File Systems (WAFS) technology for remote sites. In addition, conduct an analysis of the costs and benefits of implementing a statewide Enterprise Content Management (ECM) service that can provide a more robust and capable document management capability.

There were 910 file and print servers identified in the sample inventory. Consolidating file and print servers has been a top opportunity and best practice for server consolidation at many companies. With an increased need to better manage documents and other content; many companies are deploying more advanced systems for content management. This report describes the concepts of Wide-Area File Systems and Enterprise Content Management and suggests further investigation.

A cost and value scenario was developed to consider what the five-year impact would be for consolidating file servers to a maximum of two servers per site. For this "what-if?" scenario, 882 file servers from 78 sites were considered for consolidation to 127 servers. For this scenario, the savings would be $26M over five years. More details are covered in Overview of Cost and Value Analysis below.

Other benefits include:
- Simplified file services
- Improved document accessibility and search capabilities
- Reduced overall storage requirements

Key risks with consolidating file servers include:
- Increased WAN network requirements—relocating file servers can impact network bandwidth and latency. However, this recommendation advises consolidation within a site.
- Could create a more complex environment
- Cost of implementation

E-mail

> **Recommendation:**
>
> A plan should be developed to convert all departments to a common State e-mail system over a three-year period. Complete the e-mail architecture, engineering, deployment plan, deployment schedule, and pilot in the first year. Convert all departments to the new e-mail system in the second and third years.

In the inventory sample collected, there were 359 servers across 31 departments classified with a primary function of e-mail. Each department is responsible for

designing, engineering, deploying, and maintaining their e-mail system. DTS has a cross-department e-mail offering that began in 2005 that a few departments currently use. Alternatively, DTS could evaluate an outsourced e-mail offering for the State if security, confidentiality, service levels, and all requirements can be met.

A cost and value scenario was developed to consider what the five-year impact could be if 250 e-mail servers were consolidated to 30 at the beginning of the first year. For this scenario, the savings would be $11M over five years. More details are covered in Overview of Cost and Value Analysis below.

Other benefits include:
- An engineering team dedicated to e-mail could provide better quality services.
- A higher level of security can be maintained.
- Response to virus and security threats can be quicker without every department having resources responding.
- Standards can be better maintained.
- High availability solutions can be engineered.
- Continuity of Government e-mail strategies would be simpler to engineer and maintain.
- Better support for e-discovery.

Key risks with e-mail consolidation include:
- Network—if not architected properly, this could cause performance issues and increased bandwidth requirements
- Directory—an e-mail directory would have to be synchronized across departments
- Complexity—all State personnel would have to have access to the consolidated e-mail
- The cost of implementation

Virtualization

> **Recommendation:**
>
> The State CIO should set a goal to convert 20% of the existing servers to virtual machines over a three-year period. In addition, a plan should be developed with the cooperation of the departments to meet this goal. A *simple* quarterly tracking spreadsheet/system should be set up to record information by department. The spreadsheet and progress should be reported quarterly to the State CIO.

Often, virtualization is the first thought that comes to mind when discussing server consolidation. In fact, it presents the largest opportunity for reducing physical servers. However, virtualization does not eliminate most software licensing costs, operating system costs, and application support costs. We recommend looking at the other opportunities for server consolidation first, as they have the potential for also reducing software licensing, operating system, and application support costs.

A cost and value scenario was developed to consider what the five-year impact could be if 20% of servers were converted from physical machines to virtual machines. For this

"what-if?" scenario, it was assumed there are 9,000 servers and 1,800 were converted to virtual machines at the beginning of the first year. For this scenario, the savings would be $14M over five years. More details are covered in Overview of Cost and Value Analysis below.

Other benefits include:
- Backup and recovery could be simplified
- Hardware upgrades could occur without affecting server operating system
- Ability to load-balance
- Provides for simpler DR and Continuity of Government planning and maintenance

There are fewer risks with consolidation through virtualization but they include:
- Over-commitment of physical system resources
- Proliferation of virtual machines
- A more complex environment

Overview of Cost and Value Analysis

The cost and value analysis consisted of TCO analyses for four of the five key recommendations. The total cost of implementing each recommendation is compared to the estimated cost of an approximation of the State's current server environment. The costs are divided into four major expense categories: Hardware, Software, Facilities, and Personnel. Project implementation costs were also included in the analyses. The TCO illustrations demonstrate the potential financial value of implementing each of the key recommendations this study describes.

The server configurations used in the models are proxies to the State's current server environment. We used costs from State pricing sheets when possible and from industry standard sources when appropriate.

Financial Summary

The Key Financial Results from the analyses for each recommendation are:

In-Department - *The estimated total savings from consolidating the workloads of 9000 servers to 7650 servers is $54M—14.3% of the cost to maintain 9000 servers over five years.*

File Server - *The estimated total savings from consolidating file servers from 882 to 127 servers is $26M—72.5% of the cost to maintain 882 file servers over five years.*

E-mail - *The State could potentially save $11M, or 57% over five years of its estimated current e-mail environment costs, by consolidating 250 e-mail servers down to 30 e-mail servers.*

Virtualization - *By virtualizing 1800 servers on 225 new servers the State can potentially save $14M—18.4% over five years of the cost to maintain the 1800 old physical servers.*

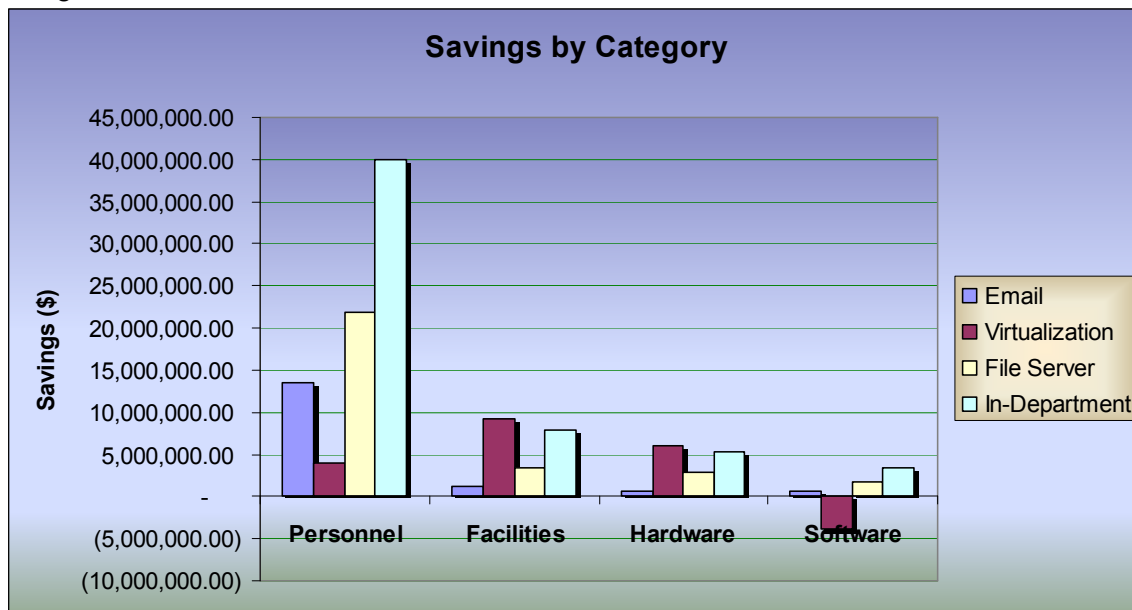Figure 1 shows the financial impact the recommendations have on each of the expense categories.

Figure 1: Savings per recommendation for each category

The following bullets summarize the impact the recommendations have on each of the four major expense categories:

Software   The recommendations affect software costs the least and virtualization actually increases software costs. However, software has the least impact on total cost.

Hardware   All of the recommendations will reduce hardware costs, with virtualization realizing the greatest hardware cost savings.

Facilities   Savings in facilities costs are generally higher than hardware and software, except in the virtualization model. Facilities costs are reduced by all of the recommendations.

Personnel   The greatest impact on costs, and where most recommendations save the most money, is in support personnel; virtualization saves on personnel but not as much as on hardware and facilities. This reduction in demand for personnel allows the State to focus on higher value IT projects and helps address the gap created by State IT personnel retiring or leaving.

Conclusion: Data center consolidation potentially has the largest cost avoidance. All of the other recommendations in this study would save the State money by reducing the number of servers the departments are currently maintaining. According to our financial TCO models, the initiative that would save the State the most money over time is In-Department server consolidation.

Energy Conservation

A welcomed benefit of server consolidation is reduced energy utilization. The State emphasizes and supports energy conservation in its initiatives and programs. Figure 2 shows the potential energy savings in megawatt-hours for each recommendation.
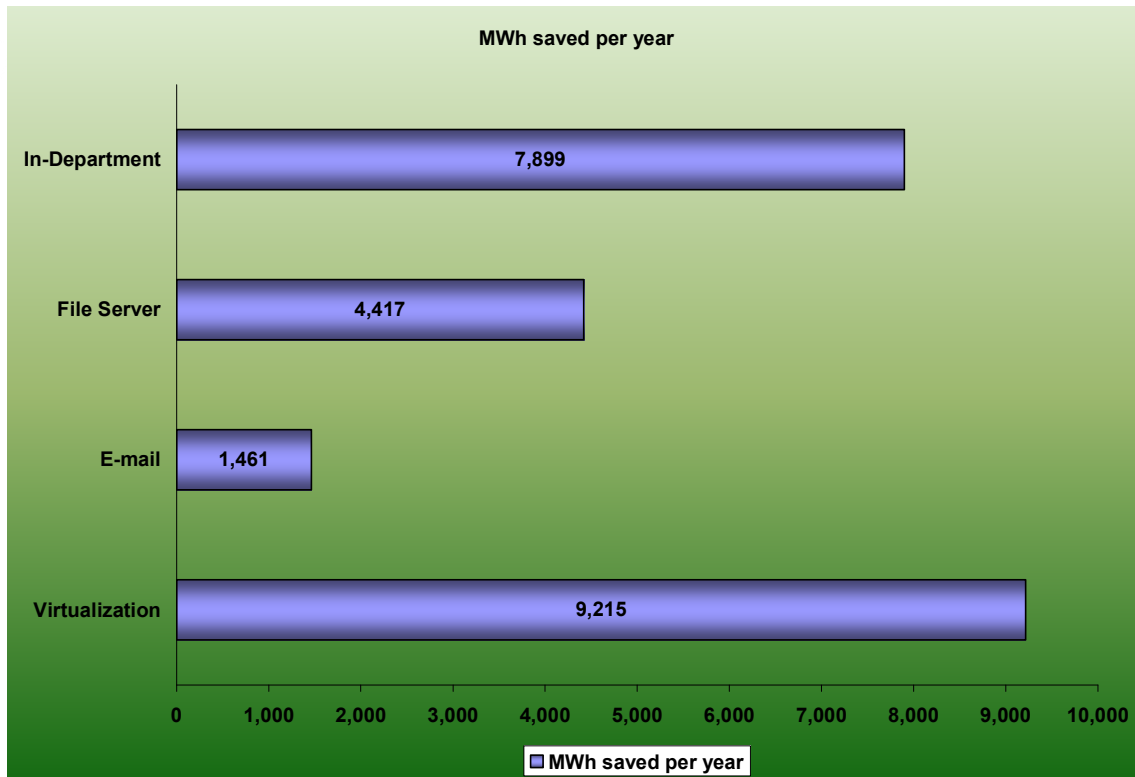

Figure 2: Energy savings by recommendation

Issues and Concerns

As the project team performed the data collection, interacted with State staff, and interviewed staff and vendors, several issues and concerns were expressed or noted. These issues and concerns do not represent concerns by all parties or departments but they are significant enough to warrant consideration. We do not provide recommendations on how these issues and concerns should be resolved. However, we agree, they should be addressed as part of any action or project. These departmental/customer issues and concerns are summarized here and further explained in Chapter 10 – Issues and Concerns.

- Centralization
  - o DTS cannot provide the same service levels that the departments themselves provide today.
  - o DTS rates are higher than what departments can provide for the same service.
  - o The overhead of doing business with DTS:

- adds additional tasks
- causes undue delays
- restricts the ability to set priorities
- slows down projects
- Department Autonomy
  - DTS does not have the same business perspective that the department has.
  - An autonomous IT group can have more control over prioritizing responses to problems according to its own business objectives.
  - An autonomous IT group can monitor and control costs better.
- Network – The network impact of consolidation of servers or services centrally needs to be addressed beforehand.
  - CSGNET backbone capacity — Centralization creates a significant increase in backbone utilization.
  - Network high-availability — If servers or services are moved, then other portions of the WAN topology could become a single-point-of-failure and cause end-user downtime.
  - Endpoint network architecture — Today, end users may not be directly connected to the CSGNET backbone; this could require end-user network changes.
  - Cost — Redesigning WAN connectivity to departments and remote offices, engineering for high-availability, and increases in bandwidth will increase network costs.
- DTS Expertise - to run centralized IT services, DTS must maintain adequate expertise to provide the services.
  - Project Cost / Competing Priorities - there are increased costs, required resources, and staff requirements in the short term that are an impact to departments' budgets.
- Server Funding - many servers were funded specifically by programs, projects, or budget line items. Some of this type of funding is specific and does not provide for consolidated systems.